

Power Line Safety for Land Surveyors

http://www.dir.ca.gov/dosh/dosh_publications/flc_eng.pdf

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G101414

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Electricity Basics

- Electricity is energy resulting from the motion of charged particles (electrons).
- Amperage (E) also known as current is the number of electrons in motion.
- Amperage or current does the work or causes the damage!**

<http://science.howstuffworks.com/electricity.htm>

Electricity Basics

- Voltage (I) can be considered the "pressure" pushing electrons along.
- Resistance (R) is a load or restriction of the flow of electrons.
- Ohm's Law: $E = I / R$ or
Current = Voltage / Resistance

<http://science.howstuffworks.com/electricity.htm>

Electricity Basics

- Electricity needs a complete or closed circuit to effectively flow
- Electricity always seeks its lowest level or ground. It may flow from higher voltage to a lower voltage source.
- Electricity will travel any path it can as it seeks a ground – possibly through you!

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Ohm's Law and the Human Body

- A man holds contacts loosely between dry fingers: resistance ~ 1,000,000ohms.
- Water sprinkled on the man's fingers to simulate sweat, and hand-to-hand resistance is reduced to ~ 17,000 ohms.
- A tighter grip reduces resistance.

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Ohm's Law and the Human Body

- Ohm's Law: $E = I \times R$ or
Current = Voltage / Resistance

Given: $I = 12,000$ volts AC at 60 Hz.
Dry hands so $R \sim 1,000,000$ ohms

Solve for E or current in milliamps:

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Ohm's Law and the Human Body

Current = 12,000 volts / 1,000,000 ohms
Times 1000 milliamps /amp = **12mA**

Current = **12 milliamps (mA)** if you are
dry and clean at 12,000 volts

What happens if you are wet or dirty?

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Ohm's Law and the Human Body

•Ohm's Law: $E = I \times R$ or
Current = Voltage / Resistance

Given: $I = 12,000$ volts AC at 60 Hz.
Man with wet hands so $R \sim 17,000$ ohms

Solve for E or current in milliamps:

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Ohm's Law and the Human Body

Current = 12,000 volts / 17,000 ohms
Times 1000 milliamps /amp = **706 Ma**

Current = **706 mA!**

Even "low" voltage can yield nearly
13 mA when wet or dirty:

Current = 220 volts / 17,000 ohms

Current = **12.9 mA**

**How much current can the typical
human body take?**

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Effect of Current on a Human Body

$E = I / R$ or Current = Voltage / Resistance

BODILY EFFECT	DIRECT CURRENT	60 Hz AC	10 kHz AC
Slight sensation felt at hand(s)	Men = 1.0 mA Women = 0.6 mA	0.4 mA 0.3 mA	7 mA 5 mA
Threshold of perception	Men = 5.2 mA Women = 3.5 mA	1.1 mA 0.7 mA	23 mA 15 mA
Painful, but voluntary muscle control maintained	Men = 62 mA Women = 41 mA	9 mA 6 mA	55 mA 37 mA
Painful, unable to let go of wires	Men = 76 mA Women = 51 mA	16 mA 10.5 mA	75 mA 50 mA
Severe pain, difficulty breathing	Men = 90 mA Women = 60 mA	23 mA 15 mA	94 mA 63 mA
Possible heart fibrillation after 3 seconds	Men = 500 mA Women = 500 mA	100 mA 100 mA	

http://www.allaboutcircuits.com/vol_1/chpt_3/2.html

Overview of Procedures & Requirements

- Plan work before going to the field.
- Recon the area upon arrival at the jobsite.
 - Identify, Discuss, & Document Hazards.
 - Discuss special circumstances (vaults, substations, etc.) with your supervisor.

Overview of Procedures & Requirements

- Work in Conformance with Power Line Safety Laws/Regulations
- Prior to extending any rod through tree canopy, ensure area above is hazard free
- Conduct Power Line Safety and Electrical Emergencies training annually

Plan the work before going to the field

- Review the request with the requestor
- Understand the purpose of the survey and the requestor's needs
- Consult available resources in the office to help plan your work and identify potential hazards
- Consider the equipment available

Recon the area upon arrival at the jobsite

- Identify and discuss all hazards before beginning work
- Discuss special circumstances with your supervisor – Sub-stations, vaults, etc.
- Document the safety meeting.
- If conditions change, recon, identify hazards, discuss, and document again.

Recon the area upon arrival at the jobsite

- Consider ALL power lines energized
- Maintain awareness of power lines at all times
- Work in conformance with applicable power line safety regulations and procedures

Work in Conformance with Safety Regulations

- What safety regulations control operations near power lines?
- What are the requirements? Are there different types of requirements?
- Do we just need to not touch power lines or are there minimum separation requirements?

Power Line Safety Law

California Division of Occupational Safety and Health Title 8 Regulations, Chapter 4. Division of Industrial Safety, Subchapter 5. Electrical Safety Orders, Group 2. High-Voltage Electrical Safety Orders, Article 37. Provisions for Preventing Accidents Due to Proximity to Overhead Lines
 §2946. Provisions for Preventing Accidents Due to Proximity to Overhead Lines.
<http://www.dir.ca.gov/Title8/2946.html>

Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

§2946 (a) General. **No person, firm, or corporation, or agent of same, shall require or permit any employee to perform any function in proximity to energized high-voltage lines; to enter upon any land, building, or other premises and there engage in any excavation, demolition, construction, repair, or other operation;**

Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

§2946 (a) *continued* - **or** to erect, install, **operate**, or store in or upon such premises **any tools**, machinery, equipment, materials, or structures (including scaffolding, house moving, well drilling, pile driving, or hoisting equipment) **unless and until danger from accidental contact with said high voltage lines has been effectively guarded against.**

Power Line Safety Law

§2946. (b) Clearances or Safeguards Required. **Except where overhead electrical distribution and transmission lines have been de-energized and visibly grounded, the following provisions shall be met:**

Power Line Safety Law

§2946. Provisions for Preventing Accidents Due to Proximity to Overhead Lines.

(b) (1) Over Lines. **The operation, erection, or handling of tools, machinery, apparatus, supplies, or materials, or any part thereof, over energized overhead high-voltage lines shall be prohibited.**

Power Line Safety Law

§2946. (b) (2) **The operation**, erection, handling, or transportation **of tools**, machinery, materials, structures, scaffolds, or the moving of any house or other building, **or any other activity where any parts of the above or any part of an employee's body will come closer than the minimum clearances from energized overhead lines as set forth in Table 1 shall be prohibited.**

Power Line Safety Law

§2946. (b) (3) Boom-type lifting or hoisting equipment. **The erection, operation or dismantling of any boom-type lifting or hoisting equipment, or any part thereof, closer than the minimum clearances from energized overhead high-voltage lines set forth in Table 2 shall be prohibited.**

Power Line Safety Law

§2946. (b) (4) Storage. **The storage of tools**, machinery, **equipment**, supplies, materials, **or apparatus under, by, or near energized overhead high-voltage lines is hereby expressly prohibited if at any time during such handling or other manipulation it is possible to bring such tools**, machinery, **equipment**, supplies, materials, **or apparatus, or any part thereof, closer than the minimum clearances from such lines as set forth in Table 1.**

Power Line Safety Law

§2946. (c) The specified clearance shall not be reduced by movement due to any strains impressed (by attachments or otherwise) upon the structures supporting the overhead high-voltage line or upon any equipment, fixtures, or attachments thereon.

Power Line Safety Law

§2946. (d) Any overhead conductor shall be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

Table 1

General MINIMUM Clearances Required

Nominal Voltage	MINIMUM Clearance
600 volts to 50,000	6 feet
over 50,000 to 345,000	10 feet
over 345,000 to 750,000	16 feet
over 750,000 to 1,000,000	20 feet

<http://www.dir.ca.gov/Title8/2946.html>

- Boom-type lifting or hoisting equipment clearances are much greater.
- The Caltrans Safety Manual (8.41) requires a minimum clearance of 3 feet at all times around low voltage power lines (less than 600 volts)

http://onramp.dot.ca.gov/hq/maint/mset/Ch8_2010_Sept_and_T-Plates_01-24-11.pdf

Table 2

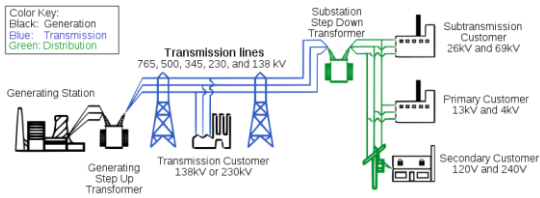
Boom-type lifting or hoisting equipment MINIMUM clearances required

Nominal Voltage	MINIMUM Clearance	
600 volts to 50,000	10 feet	
over 50,000 to 75,000	11 feet	
over 75,000 to 125,000	13 feet	
over 125,000 to 175,000	15 feet	
over 175,000 to 250,000	17 feet	
over 250,000 to 370,000	21 feet	
over 370,000 to 550,000	27 feet	
over 550,000 to 1,000,000	42 feet	

<http://www.dir.ca.gov/Title8/2946.html>

Basic Structure of the Electric System

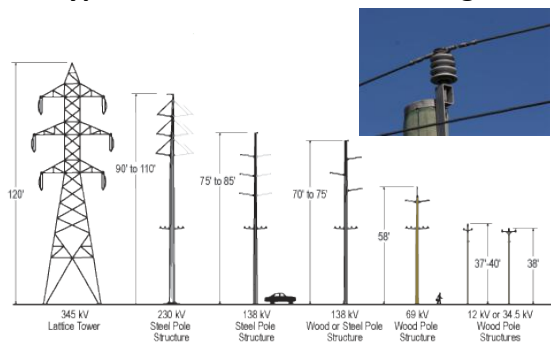
Classification	Nominal Voltage	Clearance ¹
Transmission	Over 69kV	11' or more
Distribution	120 volts to 69kV	6' to 10'



<http://www.ferc.gov/industries/electric/indus-act/reliability/blackout/ch1-3.pdf>

<http://www.pge.com/mybusiness/edusafety/systemworks/electric/currentgrid/>

Typical Towers/Poles and Voltages



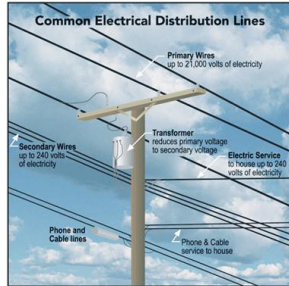
Transmission Towers Distribution Pole



Nominal Voltage?

MINIMUM Clearance per §2946

Table 1?



Tree Canopy

- Prior to extending any rod or pole through a tree or vegetation canopy, ensure the area above is hazard free.
- This includes prism poles, leveling rods, range poles made of **ANY** material.
- Fiberglass rods may still conduct electricity due to moisture or dirt on the rod.
- Refer to warning labels - ensure they are affixed to rods and legible.

Thunder and Lightning Storms

- If you can hear thunder, you are within striking distance of lightning.
- Stop working and take shelter in a grounded building or enclosed vehicle.
- If caught outside in an open field during a lightning storm, crouch down.
- Lay metal objects, prism poles, leveling rods, or range poles of **ANY** material on the ground far away from you.

<http://www.dot.state.fl.us/surveyingandmapping/Manuals/safety.pdf>

Electrical Emergencies

If a Power Line is down:

- Stay far away from it!
- Call 911 and report it immediately.
- Who, what, where, and when.
- Keep away from anything that is touching the line, like water, a tree or a fence. They too may become energized.
- Keep others away from the power line or anything that is touching the line!

<http://www.crh.noaa.gov/oax/safety/winterpower.php>

If a power line has fallen on a vehicle:

- Occupants should stay inside, unless more pressing danger (vehicle fire) exists.
- If they must exit the vehicle, jump away so that they do not touch the vehicle and ground at the same time.
- Keep feet together and shuffle or hop away from the area avoiding power lines.
- Keep people outside from touching the vehicle.

http://www.pge.com/microsite/safety_esw_nsw/esw/emergency/car.html

If someone has been shocked

- Call 911 and report it immediately.
- Who, what, where, and when.
- Visually check the distance between their body and the power line – remember to comply with separation requirements.
- If able, determine if they are still in contact with the power line or anything that is touching the line (water, tree, fence, etc.).
- Do not expose yourself to the same danger!

http://www.pge.com/microsite/safety_esw_nsw/esw/emergency/car.html

If someone has been shocked – call 911

If NOT in contact with the power line:

- Check pulse
- Check breathing
- Perform first aid or CPR as needed
- Keep them warm
- Keep talking to them

If STILL in contact with the power line:

- Stay back
- Do not touch them
- Do not move the line
- Secure the area
- Wait for emergency personnel/rescue staff

Do not expose yourself to the same danger!

http://www.pge.com/microsite/safety_esw_ngs/esw/emergency/car.html

Power Line / Electrical Safety Meeting

•Discuss Power Line Safety and Electrical Emergencies annually at a safety meeting.

•Document the safety meeting appropriately.

Power Line Safety Recap

- Plan the work before going to the field.
- Recon the jobsite before beginning work.
- Identify and discuss all hazards.
- Discuss special circumstances with your supervisor
- Document the safety meeting.

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Power Line Safety Recap – Cont.

- Consider ALL power lines as energized.
- Maintain awareness of power lines.
- Maintain required clearance from power lines – more clearance if the line is higher voltage.
- Use extreme caution when using tall rods, especially 25 foot rods.

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Power Line Safety Recap – Cont.

- Do not extend rods through a tree canopy unless you are certain it is clear above
- Conduct and document Power Line Safety & Electrical Emergencies training annually
- Remember –
Safety is everyone's responsibility.

Power Line Safety

Additional safety information:

<http://www.oshatrain.org/courses/studyguides/715studyguide.pdf>

<http://www.osha.gov/SITC/electrical/construction.html>

<http://www.humboldtrec.coop/othersites/ElectricalSafety/index.html>

<http://www.bcnv.org/firedepartment/pdfresources/lightning%20safety%201.pdf>

<http://www.pgcsafetyeducation.com/>

http://www.pgcsafetyeducation.com/contractor/look_up/index.html

http://www.pgcsafetyeducation.com/contractor/trainers/slideshows/pdfs/PGE_CB_combo_Eng_notes.pdf

<http://www.pgcsafetyeducation.com/contractor/quiz/index.html>

Any questions or comments?
